

REMARKS

Claims 23 and 29 have been amended (with reference to Fig. 2) to recite that the boron phosphide (BP)-based buffer layer 2 is a monolayer arranged between the single crystal substrate 1 and the double hetero-junction light-emitting part structure 62, the monolayer forming a junction interface with the single crystal substrate 1 and having a second opposing interface with the lower clad layer 3. In the double hetero-junction structure of Example 2 at pages 19-22, a BP low-temperature buffer layer 2 having a thickness of about 45 nm (page 16, line 33) was stacked on silicon single crystal substrate 1, and a lower clad layer 3 comprising $\text{GaN}_{0.97}\text{P}_{0.03}$ single crystal was stacked on buffer layer 2. As claimed in claims 23 and 29, the boron phosphide (BP)-based buffer (monolayer) forms a junction interface with the single crystal substrate and has a second opposing interface with the lower clad layer. Furthermore, the double hetero-junction light-emitting part structure is defined as containing a $\text{GaN}_{1-x}\text{P}_x$ ($0 < x < 1$) lower clad layer as claimed in claim 23 as originally filed.

New claims 35 and 36 recite that the BP-based buffer layer (i.e., monolayer) has a lattice constant which progressively changes from the junction interface with the single crystal substrate to the opposite side of the junction interface. Claims 37 and 38 further characterize the BP-based buffer layer as adopting a lattice constant approximating that of the single crystal substrate near the junction interface and having an inherent lattice constant of a crystal of material constituting the buffer layer (i.e., lattice constant of an original crystal) in the vicinity of the buffer layer surface opposite the junction interface with the single crystal substrate. The subject matter of new claims 35-38 is described, for example, at page 10, lines 24-31 of the specification.

New claim 39 recites that the boron phosphide (BP)-based buffer layer is a monolayer arranged between the single crystal substrate and the lower clad layer of a single hetero-junction light-emitting part structure of the device of claim 22. Such monolayer for a single hetero-junction structure is described in Example 1 at pages 16-19 and by reference to Fig. 1.

New claims 40-42 find support, for example, at page 11, lines 19-21.

Claims 22, 28 and 30 are allowed; and claims 23-27, 29 and 31-34 are rejected. Review and reconsideration on the merits are requested.

In response to the rejection under 35 U.S.C. § 112, fourth paragraph, claim 32 now properly depends from amended claim 23, so as to further limit the lower clad layer to a single crystal layer. Withdrawal of the rejection is respectfully requested.

Claims 23-27, 29 and 31-34 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Terashima et al. (U.S. Pat. No. 6,069,021) in view of Ishida et al. (U.S. Pat. No. 6,339,014) and Yoshida (JP 11171699 A).

Terashima et al. was cited as disclosing the double hetero-junction light-emitting device substantially as claimed. The Examiner relied on Ishida et al. as teaching equivalence of using P rather than As for growing of n-type GaN layers. The Examiner relied on Yoshida as disclosing a method of growing a GaNP single crystal starting from the mixture of Ga, N and P. The Examiner considered that it would have been obvious to include the teaching by Yoshida in the combined invention of Terashima et al. and Ishida et al. in order to further improve the crsytallinity of the lower cladding layer and thereby reduce charge carrier traps.

Applicant traverses, and respectfully requests the Examiner to reconsider in view of the amendment to the claims and the following remarks.

The difference between the device of amended claims 23 and 29 and Terashima et al. lies in the structure of the buffer layer. Terashima et al.'s buffer consists of three layers, namely, a first polycrystalline BP buffer layer 102, a second single crystal BP buffer layer 103 and a third BNP layer 110, the buffer layer having a total thickness of about 2 μm (column 13, line 66-column 14, line 8 and column 14, line 39).

On the other hand, the buffer layer of Example 2 of the present invention is a monolayer having a thickness of about 45 nm (page 16, line 33 and page 19, lines 30-34). This buffer layer has a lattice constant approximating that of the single crystal substrate in the vicinity of the junction interface with the single crystal substrate. As the layer thickness increases, the lattice constant becomes closer to the lattice constant of the original crystal of the material constituting the buffer layer (page 10, lines 19-31 and page 17, lines 18-30 of the specification).

Thus, claims 23 and 29 differ from the device of Terashima et al. in that the buffer layer of the invention is a monolayer forming a junction interface with the single crystal substrate and having a second opposing interface with the lower clad layer, whereas the buffer layer of Terashima et al. constitutes three distinct layers as shown above. New claims 35-38 (lattice constant) and new claims 41 and 42 (monolayer thickness not exceeding 50 nm) further distinguish the invention from Terashima et al.

Ishida et al. and Yoshida do not make up for the deficiencies of Terashima et al. Namely, none of the prior art teaches or suggests modifying the structure of Terashima et al. (a thick

buffer layer constituted by three distinct layers) so as to provide a buffer layer which is a monolayer forming a junction interface with the single crystal substrate and having a second opposing interface with the lower clad layer as required by the amended claims. Moreover, because the limitation of a monolayer as claimed in amended claims 23 and 29 is not found in any of Terashima et al., Ishida et al. and Yoshida, the combination of cited references could never achieve the present invention.

Furthermore, Applicants respectfully disagree with the Examiner's characterization of Yoshida. This reference explains the Czochralski method of GaNP single crystal growth. The crystal grown by this method is used for substrates of Group III nitride light-emitting device applications. Therefore, Yoshida does not teach application of a GaNP single crystal as required by the lower clad layer of claim 32.

For the above reasons, it is respectfully submitted that the amended claims presented herein are patentable over the cited prior art, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

Withdrawal of all rejections and allowance of claims 22-42 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

AMENDMENT UNDER 37 C.F.R. § 1.114(c)
U.S. Application No. 10/753,393

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